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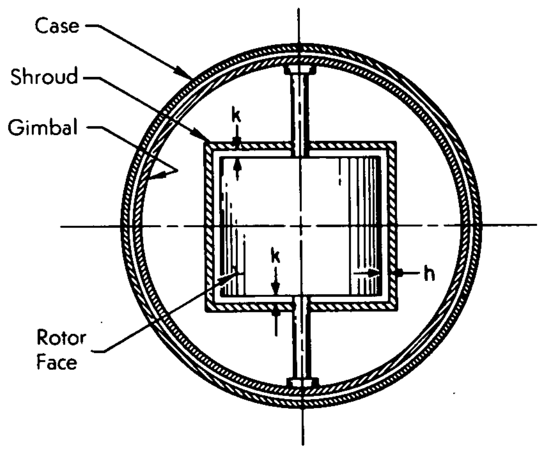
# Reduction of Noise in Gyro Outputs

## The problem:

To reduce extraneous gyro output signals further than has been accomplished by using a light gas and by decreasing the pressure of gas around the rotor.




## The solution:

Minimize the mass of gas spinning with the rotor by use of shrouds which also reduce the Reynolds number of the gas near the rotor and induce laminar flow.

## How it's done:

The ratio of the angular momentum of the surrounding gas to the angular momentum of the rotor largely determines the accuracy with which a gyro can measure low input rates; by using a light gas (such as a mixture of hydrogen and helium) the angular momentum of the gas at a given operating speed is reduced and noise torques produced by the spinning gas are decreased. For the identical reasons, further reduction of noise can be obtained by decreasing the gas pressure in a gyro; however, this approach has offered only moderate noise reduction, and it interferes with the use of gas bearings because reduction of gas pressure is necessarily accompanied by an intolerable reduction in bearing stiffness.

It has been found that gyro output noise originating from turbulent gas flow within the gyro gimbal can be significantly reduced when steady laminar flow within the gimbal of a gyro is established by surrounding the gyro rotor with a shroud or by reducing the Reynolds number of the gas within the gimbal below the critical value, that is, the lowest Reynolds number at which unsteady flow can exist. The cross-sectional schematic diagram of a simplified gyro shows that the shroud surrounding the rotor is separated a distance $h$ from the rotor's cylindrical face and a distance $k$ from its circular faces.

Any arbitrary choice for distances $h$ and $k$ yields reduced gyro output noise because the gas outside the shroud is no longer affected by the spinning rotor and it is essentially stagnant; only the gas inside the shroud is in motion, and since the mass is small, the angular momentum of the gas is small. However, if distances $h$ and $k$ are carefully selected, additional noise reduction can be realized. Specifically, when the Reynolds number is less than 41, as established by gap $h$, gas flow in the area between the rotor face and shroud will be laminar and steady, and noise will be at a minimum; distance $k$ must also be selected to be less than twice the boundary layer thickness of the gas at the circular rotor faces.

The shrouds are relatively inexpensive and do not increase significantly either the gyro weight or the

(continued overleaf)

anisoelasticity coefficient. Moreover, power consumption is not increased and in some instances the shrouds actually reduce power consumption. In any event, a steady laminar gas flow within a gyro gimbal reduces noise in the output by at least one order of magnitude.

## Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 USC 2457 (f)] to Honeywell, Inc., Aerospace Division, 2600 Ridgeway Parkway, Minneapolis, Minnesota 55413.

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